(12) Japanese Unexamined Patent Application Publication
(11) Publication No. 10-84014
(43) Publication Date: March 31, 1998
(21) Application No. 9-138579
(22) Application Date: May 28, 1997
(31) Priority Claiming No. 8-190409
(32) Priority Date: July 19, 1996
(33) Priority Claiming Country: Japan (JP)
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(54) [Title of the Invention] METHOD OF MANUFUCTURING SEMICONDUCTOR DEVICE

(57) [Abstract]
[Purpose] Manufacturing process is simplified and a plurality of circuit boards is processed optimally to improve manufacturing proficiency.
[Means for Solving Problem]
[Claims]
[Claim 1] A method of manufacturing semiconductor device comprising:
forming a belt of boards with arranging a plurality of circuit boards in a line in the lengthwise inside of a semiconductor mounting area, each of said circuit boards has electrode terminal connector placed to correspond to the position of electrode terminal formed on a semiconductor chip,
forming an anisotropic conductive adhesive layer comprising conductive particles dispersed in thermohardening or thermoplastic resin, the anisotropic conductive adhesive layer corresponds to at least said semiconductor mounting area,
softening said anisotropic conductive adhesive layer,
placing said semiconductor chip opposite to electrode terminal and said electrode terminal connector, and pressurizing said anisotropic conductive adhesive layer to connect said electrode terminal and said electrode terminal connector electrically

through said conductive particles, joining with said circuit board.

[Claim 2] In a method of manufacturing semiconductor device according to Claim 1, said anisotropic conductive adhesive layer comprises anisotropic conductive resin film.

[Claim 3] In a method of manufacturing semiconductor device according to Claim 1 or 2, said circuit board is a flexible resin board.

[Claim 4] In a method of manufacturing semiconductor device according to Claim 1, 2 or 3, said anisotropic conductive adhesive layer is formed along said electrode terminal connector in flame shape.

[Claim 5] In a method of manufacturing semiconductor device according to Claim 1, 2, 3 or 4, said anisotropic conductive adhesive layer covers serially along said lengthwise of said belt of boards including at least said semiconductor chip mounting area of circuit board.

[Claim 6] In a method of manufacturing semiconductor device according to Claim 1, 2, 3,4 or 5, said circuit board has a land connected to the wiring pattern electrically on the surface opposite of the surface on which said wiring pattern is formed and an outer connection terminal is connected to said land after said semiconductor chip is mounted on said circuit board.

[Claim 7] A method of manufacturing semiconductor device comprising:

setting a semiconductor wafer on which a plurality of semiconductor chips, each having an electrode terminal bump, are formed, and a wafer mounting substrate on which electrode terminal connectors are placed in the same arrangement as that of said electrode terminals to correspond to each of said semiconductor chips, said electrode terminal and said electrode terminal connector are facing to each other, said electrode terminal and said electrode terminal connector are connected electrically and combined in one body with an anisotropic conductive adhesive comprising conductive particles dispersed in resin,

wherein said anisotropic conductive adhesive layer comprising said anisotropic conductive adhesive is formed on a face of said wafer mounting substrate on which said electrode terminal connectors are formed,

said semiconductor wafer and said wafer mounting substrate are positioned, and said semiconductor wafer and said wafer mounting substrate are combined with said anisotropic conductive adhesive layer and said electrode terminals and said electrode terminal connectors are connected electrically,

then dicing said semiconductor wafer and said wafer mounting substrate along an outer shape of each semiconductor chip to divide into pieces.

[Claim 8] In a method of manufacturing semiconductor device according to Claim 7, a

slit is formed along dividing position of said wafer mounting substrate.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention relates to a method of manufacturing semiconductor devices.

[0002]

[Description of the Related Arts] Fig.13 shows a semiconductor device that is manufactured with mounting a semiconductor chip on a circuit board in traditional flip chip bonding method. Electrode terminal 32 is placed on a face of semiconductor chip 30 to be connected to a circuit board 10, for connecting to an electrode terminal connector 12a of a wiring pattern formed on a circuit board 10. The semiconductor chip 30, conductive material 50, such as solder, is placed on the top of its electrode 32, is mounted on the circuit board 10. The electrode 32 is placed to correspond to the electrode terminal connector 12a formed on the wiring pattern 12 of the circuit board 10. Then heat it to melt conductive material 50 and connect the electrode terminal to said wiring pattern 12 electrically and charge under fill material 52 (mainly epoxy resin) between the semiconductor chip 30 and circuit board 10, then heat the under fill material 52 to harden (cure process). Then place outer connection terminals, such as solder balls and lead pins on a land formed on the face of circuit board 10 opposed to the face the wiring pattern is formed to complete the production of a semiconductor device.

[0003]

[Problems to be Solved by the Invention] Meanwhile, in the method of manufacturing semiconductor device described above, as the process of filling under fill material 52 and the process of curing are required, production efficiency is bad. Also, mounting a semiconductor chip on each piece and performing adhesion process on each chip cause bad production efficiency. More over, when paste with metallic filler is used as said conductive material, as the metallic filler itself does not have adhesiveness, the positioning of a semiconductor chip mounted on the circuit board 10 is easily shifted.

[0004] The purpose of present invention is to provide a method of semiconductor manufacturing process that can improve manufacturing proficiency with simplifying the manufacturing process and processing a plurality of circuit boards optimally.

[0005]

[Means for Solving the Problems] In order to achieve the purpose described above, the present invention has the following structure. That is, the present invention comprises, forming a belt of boards with arranging a plurality of circuit boards in a line in the

lengthwise inside of a semiconductor mounting area, each of said circuit boards has electrode terminal connector placed to correspond to the position of electrode terminal formed on a semiconductor chip,

forming an anisotropic conductive adhesive layer comprising conductive particles dispersed in thermohardening or thermoplastic resin, the anisotropic conductive adhesive layer corresponds to at least said semiconductor mounting area,

softening said anisotropic conductive adhesive layer,

placing said semiconductor chip opposite to electrode terminal and said electrode terminal connector, and pressurizing said anisotropic conductive adhesive layer to connect said electrode terminal and said electrode terminal connector electrically through said conductive particles, joining with said circuit board.

[0006] An efficient manufacturing can be achieved as said anisotropic conductive adhesive layer comprises anisotropic conductive resin film and said circuit board comprises flexible resin substrate, a reel shape substrate can be feed consecutively, pushing out of adhesive can be controlled by forming said anisotropic conductive adhesive layer in frame shape along said electrode terminal connector. And also, said anisotropic conductive adhesive layer covers serially along said lengthwise of said belt of boards including at least said semiconductor chip mounting area of circuit board to form the anisotropic conductive adhesive layer on the belt of boards efficiently.

[0007] Said circuit board has a land connected to the wiring pattern electrically on the surface opposite of the surface on which said wiring pattern is formed and an outer connection terminal is connected to said land after said semiconductor chip is mounted on said circuit board to manufacture a semiconductor device efficiently.

[0008] A method of manufacturing semiconductor device comprising: setting a semiconductor wafer on which a plurality of semiconductor chips, each having an electrode terminal bump, are formed, and a wafer mounting substrate on which electrode terminal connectors are placed in the same arrangement as that of said electrode terminals to correspond to each of said semiconductor chips, said electrode terminal and said electrode terminal connector are facing to each other, said electrode terminal and said electrode terminal connector are connected electrically and combined in one body with an anisotropic conductive adhesive comprising conductive particles dispersed in resin, wherein said anisotropic conductive adhesive layer comprising said anisotropic conductive adhesive is formed on a face of said wafer mounting substrate on which said electrode terminal connectors are formed, said semiconductor wafer and said wafer mounting substrate are positioned, and said semiconductor wafer and said wafer mounting substrate are combined with said

anisotropic conductive adhesive layer and said electrode terminals and said electrode terminal connectors are connected electrically, then dicing said semiconductor wafer and said wafer mounting substrate along an outer shape of each semiconductor chip to divide into pieces. And also, a slit is formed along dividing position of said wafer mounting substrate to divide into each piece easily.

[0009]

[Embodiments] Hereinbelow, embodiments of present invention are shown with attached figures. Fig.1 is a cross section of a semiconductor device manufactured with the method of present invention. Fig.2 is a cross section of anisotropic conductive adhesive used for the invention. 10 is a circuit board and wiring pattern12 is formed on the surface of it. A belt of boards is formed with arranging plural of circuit boards10 in longitude. Material and shape of circuit board10 are not limited, a sheet board, TAB for example, a reel board, PCB (Printed Circuit Board) or ceramic board can be used. A land14 to which an outer connection terminal is connected is formed on the opposite surface of a circuit board10. The land14 is connected electrically to said wiring pattern12 with well known arts. For example, land14 is connected to wiring pattern electrically through a bia formed with filling a through hole with conductive material (Fig.3) or through hole16 having metal plated inner face.

[0010] 20 is anisotropic conductive adhesive (ACF) and adhered on the circuit board10. An anisotropic conductive adhesive layer is formed on said belt of boards 11, corresponding to the semiconductor chip mounting area of each circuit board10. Anisotropic conductive adhesive20 comprises heat hardening (ex. epoxy resin) or heat plastic (ex. Polyimide resin) adhesive having evenly delivered conductive particles22 and formed as a thin film layer. Conductive particles22 are evenly delivered as a layer on one surface of an adhesive layer as shown in Fig.2 and each having a uniform particle diameter (5μm, for example). The material of a particle is nickel, gold plated nickel ball or gold plated resin ball. The adhesive21 comprising resin, which is a base of anisotropic conductive adhesive is epoxy resin and so on. The thickness of an anisotropic conductive adhesive20 is generally some 10μm, 50μm for example. In Fig.2, a sheet of anisotropic conductive adhesive is protected by separate paper24,26 affixed on both sides of the sheet. Remove separate paper24 to stick to a circuit board10, and then remove separate paper26 to stick to a semiconductor chip30. Anisotropic conductive adhesive can be pasted on each chip mounting area of board.

[0011] Electrode terminal32 is place on a surface of semiconductor chip30 connected to a circuit board10 via anisotropic conductive adhesive20 corresponding to electrode terminal connector12a formed on a wiring pattern12.Electrode terminal32 is formed on

a pat of a semiconductor chip30 and comprises a gold bump. The semiconductor chip30 is positioned on anisotropic conductive adhesive20 stuck on the semiconductor chip mounting area of circuit board10 to mount. Heat to soften adhesive21 of anisotropic conductive adhesive20 and give pressure in the direction that semiconductor chip30 become close to circuit board10. A chip can be mounted, heated and pressed after softening anisotropic conductive adhesive, in this process. In this way, electrode terminal32 contact to conductive particles22 with piercing adhesive21 and conductive particles22 come between electrode terminal and electrode terminal connector12a, then electrode terminal32 is connected electrically to electrode terminal connector12a via conductive perticle22. After that, cool to harden adohesive21 and then semiconductor chip30 is connected to circuit board10 easily and surely.

[0012] For example, when wiring pattern12 is formed with copper, electrode terminal32 is formed with gold and conductive perticle22 is a nickel ball, conductive particle22 comes between electrode terminal connector12a and electrode32 and sticks into both of them, then proper electrical connection is achieved. And also, as conductive particle22 sticks into both electrode terminal connector12a and electrode32, it works as a wedge and then slipping of semiconductor chip30 on circuit board10 or detaching of semiconductor chip30 from circuit board10 is avoided. More over, as conductive particle22 comes between electrode terminal connector12a and electrode32 and sticks into both of them, uneven height (error) of electrode terminals is absorbed, then reliable electrical connection is achieved.

[0013] Hereafter, the method of manufacturing semiconductor devices is explained according to the order of steps with Fig.3. At first, remove separate paper24 and stick anisotropic conductive adhesive20 formed as a piece of film to semiconductor chip mounting area on each circuit board that is a component of a belt of boards11 as shown in Fig.3(a). Then remove separate paper26 (Fig.3(b)), stick a semiconductor chip to it temporally. Mount semiconductor chip30 on anisotropic conductive adhesive20 so that electrode terminal32 is positioned corresponding to electrode terminal connector12a on a wiring pattern. Then heat semiconductor chip with pressing in the direction it stick to circuit board10, and cool it after that (Fig.3(d)). With this process, electrode terminal32 is connected electrically to electrode terminal connector12a via conductive particle22 and semiconductor chip30 on circuit board10 is stuck to circuit board10 with heat hardening or heat plastic adhesive21 in anisotropic conductive adhesive20, then semiconductor chip30 is stuck to circuit board10 properly. Then an outer connection terminal is connected to land14 on reverse side of circuit board10, in the same process used for manufacturing traditional single sided resin sealing semiconductor devices

(Fig.3(e)). A solder ball40 can be used as an outer connection terminal.39 is a solder resister. The separate into pieces (Fig3(f)) to complete semiconductor device manufacturing process. Under fill process or cure process in prior arts are not required in the process mentioned above and then productivity is increased. As semiconductor chip10 is mounted with sticking to anisotropic conductive adhesive20, shifting after mounting can be avoided, then the yield rate can be increased.

[0014] Fig.4-6 are plans, which explain that a sheet of anisotropic conductive adhesive (20A, 20B, 20C) is provided along a belt of boards11 comprising alignment of plural of circuit board10 in the longitude direction, and is stuck corresponding to at least semiconductor chip mounting area of circuit board10, and anisotropic conductive adhesive layer is formed. Fig.4(a) explains a belt of boards11. In Fig,4(b), both a belt of boards11 and an anisotropic conductive adhesive20A are formed as belt, both of them are supplied continuously, anisotropic conductive adhesive20 including semiconductor chip mounting area is stuck to continuously. There are rectangle type and bendable reel type that pulled out from one reel and wound around the other reel. Rectangle type corresponds to PCB or ceramic board and reel type corresponds to FPC or TAB tape. A belt of boards can be consisted of plural of line and plural of row. For example, a circuit board can be formed in 5 lines and 5 rows. An anisotropic conductive adhesive20A is pulled out from a reel, separate paper24 (Fig.2) is removed and stuck to each circuit board on a belt of boards11. An anisotropic conductive adhesive20A is stuck to board and An anisotropic conductive adhesive layer is formed efficiently in this method. Anisotropic conductive adhesive can be coated on circuit board10 to form an anisotropic conductive adhesive layer.

[0015] In Fig.5, anisotropic conductive adhesive20B formed in rectangle piece is stuck to said circuit board10. In Fig.6, anisotropic conductive adhesive20C formed in rectangle piece is stuck to said circuit board10 corresponding to only the area semiconductor chip on said circuit board10 is connected electrically. Even a piece of anisotropic conductive adhesive, as mentioned, if each piece of anisotropic conductive adhesive (film) is placed on a belt of separate paper to correspond to each circuit board, fed with the belt of separate paper, can be stuck to aligned plural of circuit boards efficiently, and the productivity is increased. If anisotropic conductive adhesive is formed as a frame and stuck, the amount of leaking of adhesive between a semiconductor chip and board caused by pressure can be controlled at pressing a semiconductor chip to mount on a circuit board.

[0016] An embodiment above mentioned is a method of manufacturing semiconductor devices mounting a semiconductor chip on a belt of boards using anisotropic conductive

adhesive (ACF). In the embodiment mentioned below, a method of manufacturing semiconductor devices using semiconductor wafer before dicing as more efficient semiconductor device manufacturing method is shown. Fig.7 is a plane of semiconductor wafer before dicing. Though a semiconductor wafer50 is diced in after process, electrode terminal54 bumps are formed on all outer connection pads52 on each semiconductor chip on the wafer. Fig.8 shows a magnified drawing of electrode terminal54. Stud bump is formed with wire bonding method. Electrode54 can be formed with plating method.

[0017] Mount the semiconductor wafer50 on which electrodes54 are formed on a large wafer mounting board60 on which whole semiconductor wafer50 can be mounted via anisotropic conductive adhesive20. Fig.9 shows a magnified drawing of a part of wafer mounting board60. Electrode terminal connectors12a are formed on the wafer mounting board corresponding to the arrangement of electrode terminals 54 of semiconductor chips formed on the semiconductor wafer50. Circuit board10 is one unit that is divided by dicing. 62 is a slit placed along the dividing position at dividing a wafer mounting board. Circuit boards10 are connected each other at corners. The reason why a slit62 is placed at dividing position of wafer mounting board60 is shorten the dicing tool's cutting length of wafer mounting board60 at dividing it with a dicing tool.

[0018] Fig.10(a) is a cross section of wafer mounting board60. The structure of wafer mounting board60 is as same as said belt of boards11, electrode terminal connectors12a are formed on semiconductor chip mounting face, land14 is formed on outer connection terminal connecting face. Same anisotropic conductive adhesive20 used in said embodiment is stuck to one face of the wafer mounting board60 on which electrode terminal connectors12a are formed, to mount the semiconductor wafer50 (Fig.10(b)). The insertion of anisotropic conductive adhesive20 into slit62 can be avoided with giving slight push on anisotropic conductive adhesive20 to wafer mounting board60 and remove separate paper26.

[0019] After sticking anisotropic conductive adhesive20, position wafer mounting board60 to semiconductor wafer50, and combine a semiconductor wafer50 temporally. Heat with pushing the semiconductor wafer50 to wafer mounting board in temporal combining to combine them and connect electrode terminal connectors12a of wafer mounting board to electrode terminals54 of semiconductor wafer electrically via conductive particles delivered in anisotropic conductive adhesive20 (Fig.10(c)).As solder balls40 are used as outer connection terminals in this embodiment, connect solder balls40 to land14. Of course, connector terminals other than solder balls40 can be used,

and connecting no outer connection terminals is possible.

[0020] Lastly, combined semiconductor wafer50 and wafer mounting board60 are diced to cut off pieces of semiconductor devices. Fig.10(d) shows the method of dicing semiconductor wafer50 and wafer mounting board60 with a dicing tool70. Dicing is performed along outer shape of a semiconductor chip on the semiconductor wafer50. As a slit62 is placed on the wafer mounting board60, the range in which the dicing tool70 contacts with wafer mounting board60 is narrow, and the dicing tool70 touches almost only to a semiconductor wafer50 to dice. Dicing different materials causes decreasing of cutting efficiency of a dicing tool, and give damage on the dicing tool. Placing a slit62 on the wafer mounting board, like this embodiment, shortens the distance that the dicing tool touches anisotropic conductive adhesive20, then the combined semiconductor wafer50 and wafer mounting board60 are diced correctly. Of course, semiconductor devices can be manufactured dicing after positioning and combining semiconductor wafer50 and wafer mounting board60 using a single board without a slit62 on wafer mounting board60. Fig.11 is a cross section of a semiconductor device manufactured with present embodiment.

[0021] In the embodiment above mentioned, a semiconductor device is manufactured with sticking anisotropic conductive adhesive20 to wafer mounting board60 on which electrode terminal connectors12a are formed, then semiconductor wafer50 is stuck, on the contrary to the method, shown in Fig.12, semiconductor devices can be manufactured with after laminating anisotropic conductive adhesive20 on the semiconductor wafer on which electrode terminals54 are formed (Fig.12(a)), position the wafer mounting board via anisotropic conductive adhesive20 and combine, and then dicing semiconductor wafer50 and wafer mounting board60.

[0022] The method to manufacture semiconductor devices with combine semiconductor wafer50 and wafer mounting board60 via anisotropic conductive adhesive20 and then dicing is very effective in the view of production efficiency. That is, the productivity can be improved compare with handling pieces of semiconductor chips, as the semiconductor wafer50 itself is used in this method, and as the arrangement of areas on the wafer mounting board to be circuit boards10 are correspond to the semiconductor wafer50, the arranging density of the circuit board10 to be used for semiconductor devices is increased, then the loss of board is avoided and the production cost of boards is largely decreased.

[0023]

[Advantage] In the present invention, an anisotropic conductive adhesive layer is set on the semiconductor chip mounting area on each circuit board of a belt of boards

beforehand, then soften and press the anisotropic conductive adhesive layer to combine a semiconductor chip with a circuit board. Then under fill process and cure process in prior arts are not required, the manufacturing processes are simplified, the productivity can be improved as plural of circuit boards are processed at the same time using a belt of boards. The method of using a semiconductor wafer and wafer mounting board improves production efficiency of manufacturing semiconductor devices.

[Brief Description of the Drawings]

[Fig.1] A cross section of a semiconductor device manufactured with the method of present invention.

[Fig.2] A cross section of anisotropic conductive adhesive used in the present invention.

[Fig.3] An explanatory diagram for manufacturing method in the present invention.

[Fig.4] A explanatory plane for sticking of anisotropic conductive adhesive belt to a belt of boards.

[Fig.5] A explanatory plane for sticking of anisotropic conductive adhesive piece to a belt of boards.

[Fig.6] A explanatory plane for sticking of frame likes anisotropic conductive adhesive piece to a belt of boards.

[Fig.7] A plane of a semiconductor wafer.

[Fig.8] A cross section of a semiconductor wafer on which stud bump electrode terminals are formed.

[Fig.9] A plane of a part of magnified wafer mounting board.

[Fig.10] An explanatory diagram for manufacturing semiconductor devices using a semiconductor wafer and a wafer mounting board.

[Fig.11] A cross section of a semiconductor device manufactured with the present invention.

[Fig.12] An explanatory diagram for manufacturing semiconductor devices with binding a semiconductor wafer and a wafer mounting board.

[Fig.13] A cross section of a semiconductor device manufactured with the prior art.

[Reference Numerals]

10 circuit board

11 a belt of boards

12 wiring pattern

12a electrode terminal connector

14 land

20 anisotropic conductive adhesive

21 adhesive

22 conductive particle
24 separate paper
26 separate paper
30 semiconductor chip
32 electrode terminal
40 solder ball
50 semiconductor wafer
54 electrode terminal
60 wafer mounting board
62 slit
70 dicing tool